pyramids. There are recesses or valleys 53 between adjacent abrasive composite elements. There is also more than one row of pyramidal abrasive composite elements shown in which the second row of abrasive composite elements is offset from the first row. Abrasive composite elements 54 comprise a plurality of abrasive particles 56 dispersed in binder 55. Outermost point 51 of each abrasive composite 54 first contacts a workpiece during processing, and as processing proceeds the abrasive composite elements wear or erode away substantially uniformly toward backing 59.

At page 9, lines 27-31, please replace the paragraph with the following:

Fixed abrasive article 50 of figure 10 includes an example of a wear indicator, which is a visible marker at the base of an abrasive composite element 54, and which is illustrated by shaded portion 60. After an amount of abrasive composite element 54 is worn or eroded away, the visible marker becomes visible at the upper (abraded) surface of fixed abrasive article 50.

At pages 9, line 32-page 10, line 5, please replace the paragraph with the following:

Optionally, as illustrated in figure 3, the fixed abrasive article does not require a separate backing. Figure 3 shows fixed abrasive article 600 which comprises a textured, three-dimensional abrasive body having a textured abrasive surface 602 making up a general abrasive surface 606, and being provided by an integral structure composed of a plurality of pyramidal-shaped abrasive composites 604 in which abrasive particles 601 are dispersed in a binder 603. A visible marker is included as a wear indicator, as represented by shaded area 605.

At page 13, lines 3-16, please replace the paragraph with the following:

As one specific example, a fixed abrasive article can include a visual wear indicator in the form of a colored layer over abrasive composite elements, e.g., over at least a portion

of the abrasive surface, or over the entire abrasive surface. Fixed abrasive article 620 illustrated in figure 4 includes a colored layer 622, e.g., a paint, applied over pyramidal abrasive composite elements. The abrasive composite elements can be of any shape, as long as the amount of wear indicator remaining on the fixed abrasive article will change (e.g., be reduced) with use and wear of the fixed abrasive article, and the change can be measured. Preferred shapes can include at least one non-vertical wear surface, such as pyramids or ridges, as shown in figure 4, that will experience a color change when the abrasive surface is viewed. Other examples include hemispherical elements, conical elements, and even cylindrical elements, especially those that include a shoulder, ledge, ring, or other form of a nonvertical surface, e.g., step or a ramp, that if coated with a colored layer will gradually or abruptly change color during use of the fixed abrasive article.

At page 13, line 22-page 14, line 4, please replace the paragraph with the following:

Specific examples of this type of wear indicator include wear indicators that are present at a position that causes the wear indicator to become visible or otherwise detectable (or relatively more or less visible or detectable) after some of the abrasive composite element is worn or eroded away. Figure 1 illustrates exemplary abrasive article 2 comprising abrasive composite elements 4 in the form of posts. The abrasive composite elements 4 include a binder and abrasive particles (the abrasive particles are not specifically shown) and a visible marker, e.g., a visible dye, at a lower portion 10 of the elements 4. During use, portions 6 of the elements that do not contain visible wear indicator, i.e., the portions above the portions 10 that do contain visible wear indicator, will wear or erode away. Upon such erosion down to the level of the abrasive composite element where the visual wear indicator is first present, represented by lines 8 in figure 1, the wear indicator becomes visible. The abrasive article can then be replaced with a fresh abrasive article. Visual wear indicator may be present in one, several, or all of the abrasive composite elements of such a fixed abrasive article, e.g., in a pattern such as a circle or line, or within all abrasive composite elements of a fixed abrasive article.

At page 14, lines 5-13, please replace the paragraph with the following:

The wear indicator of figure 1 need not be visual, but can be any material that becomes detectable upon contact with the workpiece, after wear of the abrasive composite elements. As another example, lower portion 10 may include a chemical, e.g., dispersed or encapsulated, that will evolve from the fixed abrasive article when lower portion 10 contacts the workpiece during processing. The chemical may be directly detectable in the atmosphere of the process or may be indirectly detectable in the effluent or working fluid of the process, for example by reacting with another material to cause a color change, a pH change, or some other detectable chemical phenomena.

At page 14, line 24-page 15, line 17, please replace the paragraph with the following:

Another example of a wear indicator is depicted at figure 2. In this embodiment a wear indicator element 12 (represented by the shaded area), i.e., a "wear indicator composite," comprising a binder and a wear indicator, is located in an abrasive article 16 in a space between abrasive composite elements 14. The wear indicator element 12 is not necessarily a portion of an abrasive composite element (although it may well include a binder and abrasive or other particles), because it does not have to take on the shape or composition of a fixed abrasive composite element. Here, wear indicator element 12 can be considered a separate component of the fixed abrasive article, shown in this example to be attached to abrasive composite elements 14. The upper surface of wear indicator element 12 comes into contact with a surface of a substrate when adjacent posts 14 have worn down to the level of the surface of wear indicator element 12. Wear indicator element 12 then provides some indication that the wear indicator element 12 is contacting the substrate. This indication can be, e.g., by a visual indication, for example a color change, e.g., a color may appear or disappear upon abrasion of the surface of the wear indicator element 12; by a magnetic indication, e.g., by sensing a magnetic wear indicator coated on the top surface of wear indicator element that upon contact with the substrate will abrade away; by an increase in friction or abrasion caused by the contact; by the presence of another type of material

eroded out of the wear indicator element 12 such as a chemical that is directly or indirectly detectable in the effluent, working fluid, or atmosphere of the process; or by any other effective mechanism. Wear indicators of this type may be placed at one or at numerous different positions throughout an abrasive surface of a fixed abrasive article, e.g., between abrasive composite elements. There may be one or a number of such wear indicators over a surface of a fixed abrasive article, and a group of wear indicators may optionally form a pattern such as a line or circle that will be visible during use, e.g., while the abrasive article is spinning or otherwise moving.

At page 15, lines 18-26, please replace the paragraph with the following:

In figure 2, the wear indicator element 12 of abrasive article 16 can be comprised of any of the previously-identified materials useful for wear indicators, including a binder, and including any one or more of a visual marker, a metallic material, a magnetic material, etc., or an abrasive material such as abrasive particles. As one embodiment, an upper surface of wear indicator 12 can be coated with a colored coating (not shown) that wears away when posts 14 wear down to the level of the upper surface; at that level of wear, the colored coating wears away and causes a change in the fixed abrasive article color that indicates that a degree of wear has occurred.

At page 16, lines 9-24, please replace the paragraph with the following:

An example of this embodiment is shown in figure 5. In the figure, fixed abrasive article 630 comprises an embedded wear bar 632. The wear bar can be any material that is detectable and whose position can be determined through the abrasive article 630. Examples of useful materials for the wear bar can depend on the composition of the fixed abrasive article and the method used for detecting the position of the wear bar. Some useful materials include metallic materials, magnetic materials, and possibly even colored materials if at least a portion of the fixed abrasive article is transparent to visible light. While figure 5 shows a wear bar, the detectable material may take any useful form. In use, the fixed

abrasive article contacts a substrate 640 and wears away abrasive composite elements 604, which reduces the distance 636 between the wear bar 632 and the surface 638 of substrate 640. The distance 636 can be measured by measuring the position of the wear bar 632, and this can be used to keep track of the amount of wear and the useful lifetime remaining of fixed abrasive article 630; i.e., when a certain minimum distance is reached, the fixed abrasive article 630 can be replaced with a fresh fixed abrasive article.

At page 17, lines 1-8, please replace the paragraph with the following:

Figure 2 can be used to illustrate an abradable wear indicator on a surface of a fixed abrasive article. As previously mentioned, the upper surface of wear indicator element 12 can be coated with an abradable wear indicator (not shown) such as a detectable colored, metallic, or magnetic material. During the useful lifetime of fixed abrasive article 16, the abradable wear indicator is present and detectable; upon wear of the abrasive composite elements 14 to and past the level of the surface of the wear indicator element 12, the abradable wear indicator coated at the surface of the wear indicator element 12 will abrade away and no longer be detectable.

At page 17, lines 9-18, please replace the paragraph with the following:

Figure 7 illustrates an abradable wear indicator located below a surface of, e.g., embedded in, a fixed abrasive article 618. Abradable wear indicators 607 are located below abrasive surface 602, embedded in abrasive composite elements 604 at a depth that will cause them to be detectable while present, but where they will be worn or abraded away as abrasive composite elements 604 wear down. The depth of abradable wear indicators 607 can be a depth below surface 602 that will cause the indicators 607 to wear away at a desired, optimal, or convenient time during the life of fixed abrasive article 600. Also, while figure 7 shows three abradable wear indicators in the form of linear elements or bars, any number and any size or shape, may be used.

At page 18, lines 4-10, please replace the paragraph with the following:

More specifically, a fixed abrasive article as illustrated in figure 6 can include a transparent wear indicator 646 in the form of a solid but transparent window, e.g., aperture (hole), glass, polycarbonate, or another material that is transparent to a type of sensing radiation, and that allows a sensing radiation, e.g., in the form of a beam, to pass through the window and back. The transparent wear indicator does not have to be transparent to visible radiation, and radiation other than visible radiation can be useful.

At page 19, lines 1-9, please replace the paragraph with the following:

Figure 8 illustrates how a wear indicator can take the shape, form, or design of a fixed abrasive article, e.g., a form, shape, design of an abrasive composite or a wear indicator composite, and in the figure, the form of a void or apperature designed into the fixed abrasive article. Specifically, fixed abrasive article 619 includes voids 608 extending partially through fixed abrasive article 619, starting from the bottom. Upon wearing of the portions of abrasive composite elements 604 located just above voids 608, the voids will become visible apertures through the fixed abrasive article. These can be detected visually or based on a change in the frictional forces between the fixed abrasive article and a substrate, or otherwise.

At page 24, lines 5-10, please replace the paragraph with the following:

Figure 9 illustrates a simplified apparatus for planarizing semiconductor wafers using fixed abrasive articles of the invention. Apparatuses of the type illustrated and numerous variations and other types of apparatus are well known for use with polishing pads and loose abrasive slurries. An example of a suitable commercially available apparatus is a CMP machine available from IPEC/WESTECH of Phoenix, AZ.

At page 24, lines 11-15, please replace the paragraph with the following:

As shown in Figure 9, apparatus 30 comprises head unit 31 that is connected to a motor (not shown). Chuck 32 extends from head unit 31; an example of such a chuck is a gimbal chuck. Chuck 32 preferably is designed to accommodate different forces and pivot so that the fixed abrasive article can maintain desired surface finish and flatness on the wafer.

At page 26, lines 4-6, please replace the paragraph with the following:

Referring to figure 9, reservoir 37 holds liquid 43 which is pumped through tubing 38 into the interface between semiconductor wafer 34 and abrasive surface 42.

At page 26, lines 9-15, please replace the paragraph with the following:

Figure 9 also illustrates how wear of a fixed abrasive article can be monitored according to the invention, using a visual wear indicator. Figure 9 illustrates a photodetector 49 that monitors the color of fixed abrasive article 39. During processing, abrasive composite elements of fixed abrasive article 39 wear down or erode, exposing a visual (e.g., colored) marker that can be detected by photodetector 49. When the visual marker is detected, fixed abrasive article 39 is understood to be worn and can be replaced with a fresh fixed abrasive article.

At page 29, lines 1-15, please replace the paragraph with the following:

A problem which arises during CMP is effective supplying chemicals underneath the wafer resulting in starvation at the wafer center. This would apply to both fixed abrasive and conventional slurry CMP. As the wafer rotates, a leading edge-trailing edge situation arises. But in any case, around the edge of the wafer at some point all of the different points on the edge get to be leading at some point and all of them get to be trailing at some point,

but the center is always the center. There may be some depletion across the wafer during rotation and the wafer is rotating around the center of the wafer. Thus, the center of the wafer always experiences some medium chemical concentration. Accordingly, the chemical concentration is going up and down and up and down causing a very unstable situation. This problem is solved by providing a permeable abrasive pad so that the wafer sees a uniform concentration of chemicals everywhere. The web is permeable in a vertical direction, coming up from the bottom. The chemicals would be supplied through the platen itself up directly through the membrane.

At page 29, lines 16-17, please replace the paragraph with the following:

Another advantage is that if air bubbles are trapped, by providing a non-flat surface to the abrasive, it would permeate out.

At page 29, lines 28-32, please replace the paragraph with the following:

This invention entails impregnating the plastic matrix of a web with process chemicals. Such posts are typically about 50 microns tall and about 200 microns in diameter. But the shape of it in no way limits the invention. During polishing, the first wafer is at the top of the post, which wears down so that later wafers are exposed to a lower part of the post.

At page 31, line 27-page 32, line 2, please replace the paragraph with the following:

By combining the different shapes on the web the benefits of the different shapes are achieved. Later on in the process, copper, for example, begins to clear over oxide and a barrier layer of Tantalum (Ta) is exposed. The Ta must also be removed stopping on the oxide. This aspect involves tailoring the selectivity, whereas, conventionally, the web is very selective to both Ta and oxide, e.g., about 500 to 1 on Ta and about 250 to 1 on oxide.

Aspects of this embodiment include a web with a selectivity of 1 to 1 to 1, as by strategically formulating the posts with suitable chemistry for targeted etching.

At page 32, lines 8-25, please replace the paragraph with the following:

This invention includes the concept of varying the compressibility of the web to obtain non-linear compressibility to effectively treat both high and low spots on a wafer. Under compression, the modulus of compressibility would increase significantly as the material is compressed to about 50%, as with common sealant elastomers that are loaded with a silica filler to provide strength and body. As the squishy sealant is compressed, the polymer compresses, but upon filler to filler contact, compression ceases completely, i.e., a very non-linear compressibility. In this embodiment, a post is provided so that when a force is applied, it can compress a certain amount, but then further force doesn't compress it any further, i.e., a non-linear spring. With a wafer having a high part and a low part, the high part contacts the post and compress it to obtain a large force. Where they are in contact with the low parts, a weak force is obtained. By providing a non-linear force, part of the wafer protrudes a number of microns beyond a low spot and compresses a post to a greater extent making it even stiffer so that it pushes back harder. The modulus of compressibility of the post can be changed by suitable crosslinking in the polymer, varying the amount of filler, or changing the nature of the polymer, e.g., a more linear polymer or a more trifunctional or even a quadrifunctional polymer. This is well known art in the polymer industry.

At page 33, lines 20-29, please replace the paragraph with the following:

This embodiment relates to a fixed abrasive web comprising a plurality of elongated posts on a sheet. Conventional posts have a diameter of about 125 to 1,000 microns, with the diameter about twice the height. Accordingly, conventional posts extend up to 500 microns above the backing sheet. The present embodiment comprises forming posts with a ratio of the height to diameter opposite conventional practices, so that the posts are significantly higher than their diameter. In this way, a multiplicity of very tall posts are formed. Instead

of polishing on their upper edges, these tall posts lean over like bristles and polish on their sides that wear off during CMP. Thus, the tall posts are formed so that they lean over during CMP and flow brushing from the side and round off at the top.

At page 34, lines 16-17, please delete the entire paragraph.

At page 34, lines 20-30, please replace the paragraph with the following:

This invention relates to improvements with respect to in situ rate measurement (ISRM) devices. The ISRM device is a laser base device that shines a light though the web material to provide a measurement of film thickness. The web material is a composite of abrasive filler and a polymer binder. The dispersed particles typically have a different refractive index than the matrix thereby resulting in scattering. It is therefore, very difficult to get the laser through with detectable intensity, particularly since it has to make the trip twice, (i.e.) it has to go in reflect and come back out. This embodiment solves that problem changing the refractory index of the polymer matrix to match that of the abrasive particles. The refractory of the polymers can easily be adjusted to match it to about that of the refractory index to obtain totally clear material.

At page 35, lines 5-23, please replace the paragraph with the following:

The invention resides in forming a fixed abrasive web with negative posts, as in U.S. Patent 5,014,468 and incorporating chemicals in the negative recesses. Typically, the posts form about 10-25 percent of the surface of the pad, leaving at least about 75% as open channel, i.e., a connected phase employing terminology from percolation theory. The connected phase is the one connected all the way through. The open space is the connected phase; the posts are disconnected from one another. This embodiment reverses the conventional fixed abrasive pad by making the open space the disconnected phase and making the posts the connected phase, thereby maintaining the same relative amount of post area. However, a region can be walled off or damned, as by forming a hexagonal recess

which is isolated, such that the posts constitute walls around these isolated recesses. In the process of contacting the web and the wafer, the chemicals are supplied in these recesses. The chemicals are primarily liquid and the concern with the posts where the open spaces, the connected phases, is that the liquid can mix around and go around. If the chemicals are supplied in these isolated recesses, then the chemicals are going to be transported with the web and remain in one place. Therefore, the chemistry is basically isolated through a number of different little cells, each cell a pocket. A circuitous or tortuous path can be formed between the posts so that you're not totally isolated, but effectively isolated.

At page 35, lines 26-33, please replace the paragraph with the following:

This embodiment resides in proving a non-homogenous web with different areas to perform different functions, thereby providing greater flexibility. For example, posts can be used to perform buffing. This embodiment provides macroscopic regions of the web which are different for different functions. For example, one area of the web can be for copper polish and another area for example, would remove Ta, thereby achieving a macroscopic effect. This can be easily implemented in round/round polishing when the wafer travels around in a circle on the web material, and it rotates in its place.

At page 36, lines 12-17, please replace the paragraph with the following:

The problem addressed by the present invention is that the conventional web backing material, i.e., believed to be a polyester-based material, sheds on abrasion. Frictional interaction between the platen and the web during advancement generates particles in the process. The solution to this problem resides providing a non-shedding backing material, such as a self-lubricating plastic. Such self-lubricating plastics are conventional.